

CLEANUP REMEDIES

ZERO-VALENT IRON (ZVI)

What is Zero-Valent Iron?

Zero-Valent Iron (ZVI) is one of the remedial technologies selected to clean up solvents in the groundwater on the western side of Dunn Field. ZVI has been used to treat solvents in the groundwater in a treatability study on Dunn Field and in an early implementation on Memphis, Light, Gas and Water (MLGW) property northwest of Dunn Field.

How does it work?

ZVI is a natural material similar to iron filings or powder. It acts as a catalyst to breakdown the chemicals in groundwater – such as the solvents known as chlorinated volatile organic compounds (CVOCs) that are present in the groundwater at the Depot – into safe compounds. This chemical reaction is called reductive dechlorination.

Will the reaction of the iron with the solvents cause the formation of any other chemicals?

A pilot study that was completed at the Depot in April 2004 showed that Zero Valent Iron (ZVI) injection effectively reduced solvents in the groundwater by an average of 95 per cent. The formation of other chemicals, known as byproducts, did not occur.

Once ZVI injection has been completed, groundwater monitoring will be implemented to determine the effectiveness of the remedy, and ensure environmental conditions meet the cleanup objectives defined in the Record of Decision (ROD) for Dunn Field for safe industrial and recreational reuse.

The ROD provides a complete analysis of the remedies chosen for Dunn Field. Each remedy and technology was thoroughly evaluated for safety and efficacy – including the potential for reactivity or the creation of undesirable breakdown products – and has been approved by USEPA and TDEC.

What happens if the iron comes in contact with other chemicals other than CVOCs?

No adverse reactions are expected from use of ZVI during the planned remedial actions. ZVI was selected on the basis of its effectiveness in treating the primary groundwater contaminants at the former Depot. No adverse reactions to other chemicals present at low concentrations were observed during the ZVI field study at Dunn Field or the early remedy implementation on MLGW property west of Dunn Field.

Each remedy and technology being used at the Depot has been thoroughly evaluated for safety and effectiveness, including the potential for reactivity or the creation of undesirable breakdown products, and has been approved by USEPA and TDEC. In addition, pilot studies have been conducted to ensure these remedies will be safe and effective under the environmental conditions at the Depot. The Record of Decision

(ROD) for Dunn Field provides a complete analysis of the remedies chosen for Dunn Field.

How do we know this treatment is safe?

Iron is a naturally-occurring element that is essential for health. ZVI is a food-grade, powdered iron product that has been used to treat groundwater impacted by CVOCs since the early 1990s. USEPA considers it to be a safe substance that presents no unacceptable risks to human health or the environment.

The Record of Decision (ROD) for Dunn Field provided a complete analysis of the remedies chosen for the Depot, including a review of their performance at other cleanup sites. Each remedy was thoroughly evaluated for safety and efficacy and has been approved by USEPA and TDEC. In addition, pilot studies have been conducted to ensure these remedies will be safe and effective under the environmental conditions at the Depot.

Why did you decide to use this technology at the Depot?

ZVI is recognized by USEPA as a cost-effective and reliable technology to treat groundwater impacted by chemicals such as the solvents known as volatile organic compounds (VOCs) in the groundwater at the Depot. At many sites, the use of ZVI is replacing the more traditional pump and treat systems as the preferred method for addressing environmental conditions in groundwater.

The Dunn Field Record of Decision (ROD) provides the justification for the preferred cleanup remedies chosen at the Depot. Each remedy was selected to ensure the site meets health protective standards for the designated future reuse. ZVI was selected, in part, because it provides effective treatment of a wide range of groundwater contaminants including the primary compounds present at the Depot

How do you know this technology will work here?

ZVI has been used effectively at sites around the world since 1991. A pilot study that was completed at the Depot in April 2004 showed that Zero Valent Iron (ZVI) injection effectively reduced solvents in the groundwater by an average of 95 per cent.

What happens if it doesn't work?

A pilot study that was completed at the Depot in April 2004 showed that Zero Valent Iron (ZVI) injection effectively reduced solvents in the groundwater by an average of 95 per cent. Based on those results, and the performance of ZVI at other sites around the world, the BCT is confident that ZVI will work effectively at the Depot. If necessary, additional ZVI injections can be made or other clean-up technologies implemented to augment the ZVI.

USEPA, DLA, and TDEC will review the effectiveness of this remedy at five-year intervals to ensure the site continues to be safe for community reuse.

Has this remedy already been used in the community?

ZVI was used November 2004 to January 2005 during an early remedy implementation to treat off-site impacts of solvents in groundwater beneath Memphis, Light, Gas and Water (MLGW) property northwest of Dunn Field. Sampling in January and March 2005 indicated that concentrations of solvents have been reduced by 50 per cent.

Groundwater monitoring will continue and the data will be used in the Off Depot Groundwater Remedial Design to determine if additional ZVI treatments are required to achieve cleanup goals.

What's the difference between ZVI injection and a PRB?

ZVI injection involves using pressurized nitrogen to inject ZVI directly into the groundwater through a small number of boreholes drilled through the ground. This allows us to go to specific areas where we know we have high concentrations, and actively treat the groundwater within a radius of approximately 40 feet.

A Permeable Reactive Barrier (PRB) is created by injecting ZVI encased in food-grade gel through a series of boreholes spaced approximately five to 15 feet apart. A PRB several hundred feet long will be installed west of Dunn Field to create a treatment zone that will treat groundwater as the ground water moves naturally through the PRB.

Will ZVI clean up all of the environmental impacts in this area?

No, ZVI will be used to clean up CVOCs in the shallow aquifer. Other cleanup remedies such as soil vapor extraction and disposal site excavation will be used to meet cleanup objectives for other areas of the Depot.

The nature and extent of environmental impacts at the Depot, and an assessment of possible risks to human health and the environment, are documented in Remedial Investigation (RI) for the Main Installation and Dunn Field. The Records of Decision (ROD) for Dunn Field provides a complete analysis of the remedies chosen for the Depot and the contaminants to be addressed in the cleanup.

A pilot study that was completed at the Depot in April 2004 showed that Zero Valent Iron (ZVI) injection effectively reduced solvents in the groundwater by an average of 95 per cent. The remaining low concentrations of solvents will be treated through monitored natural attenuation with long-term monitoring to ensure that these remedies are effective.

Can ZVI get into the drinking water?

ZVI will be used at the Depot to treat groundwater in the shallow aquifer, which is located 80-100 feet below the ground surface. ZVI will not impact the City's drinking water, which comes from the Memphis Sand aquifer located approximately 250 feet below the surface in the Dunn Field area. Once ZVI is in the ground, the iron particles will bind with the soil and return to its normal state through a natural process called oxidation.

How long will it take before the groundwater is clean?

Levels of chlorinated volatile organic compounds in the ground water are expected to reach the Safe Drinking Water Act requirements by 2019.

We plan to have all groundwater remedies in place by 2008. Groundwater treatment will take a number of years and long-term monitoring of groundwater will be performed to judge the effectiveness of the remedies. USEPA and TDEC will review the effectiveness of this remedy at five-year intervals to ensure the site continues to be safe for community reuse.

How long will that iron stay in the ground? Could it move off site and into the community?

ZVI is considered a safe substance that presents no unacceptable risks to human health or the environment.

The pilot study we conducted demonstrated that ZVI continues to treat contaminated groundwater that flows into the injection area for an estimated 12 to 18 months after injection. Once ZVI is in the ground, the iron particles will bind with the soil and eventually break down through a natural process called oxidation.

The iron in the PRB is expected to be effective for a longer period of time (at least 10 years). In addition, the iron will be no closer to the ground surface than about 70 feet. Once in place it does not move and will not get into the community.

What are you going to do to reduce the noise during your work on Dunn Field?

The Depot's environmental contractors will make every effort to minimize disruption to the community during the cleanup activities. More information about these efforts will be included in the remaining Remedial Designs that will be completed for the cleanup remedies at Dunn Field.

I read a story in the Commercial Appeal about enhanced bioremediation. Is that the same as ZVI?

No, they are two different cleanup technologies that have been approved for use at the Depot.

Enhanced bioremediation is one of the technologies approved as a remedy for groundwater at the Main Installation. It involves injecting nutrients that feed organisms already in the environment. These organisms help to naturally break down or degrade certain chemicals. By encouraging the growth of these organisms, we can effectively speed up this process, which is known as enhanced bioremediation.

ZVI is a food-grade powdered iron product that has been used to treat groundwater impacted by CVOCs since the early 1990s. USEPA considers it to be a safe substance that presents no unacceptable risks to human health or the environment.

EXCAVATION, TRANSPORT AND DISPOSAL (ET&D)

What is ET&D and where is it being used?

Excavation, Transport and Disposal (ET&D) is the remedy approved in the Dunn Field Record of Decision (ROD) for the disposal sites area on Dunn Field. Work began in March 2005 to remove buried waste and affected soil from five disposal sites. The first phase was completed in May and the second phase will be completed in July/August 2005.

The excavated soil will be sampled to ensure waste is taken to the appropriate facility for disposal. Non-hazardous waste will be transported to the Browning Ferris Industries (BFI) South Shelby landfill. Soil and debris that are classified as hazardous waste will be transported to the Emelle Treatment Facility in Emelle, Alabama. Excavated soil is being replaced with clean fill at each disposal site.

Following excavation, the environmental contractors will collect soil samples from each disposal site to confirm that cleanup goals have been met. During ET&D activities, the environmental contractors are following a site safety plan to protect workers, residents and the environment. The plan includes air monitoring, dust control measures, equipment cleaning, and personal protective equipment for workers.

What kinds of materials were in the disposal sites?

Materials excavated from the disposal sites include discarded, empty drums, construction debris, metal and glass. Site 3 had numerous 1-quart bottles with clear liquid. Tests indicate the liquid contained acidified water with ortho-toluidine hydrochloride, a compound used to test water for the presence of chlorine.

Was the community notified that this activity would be taking place?

Excavation, transportation and disposal (ET&D) was selected as the remedy for the disposal sites in the Dunn Field Record of Decision (ROD), which was approved in April 2004. The Disposal Sites Remedial Design was distributed to the Restoration Advisory Board (RAB) in June 2004. A public briefing on the Remedial Design for the remedy was held in January 2005.

ENHANCED BIOREMEDIATION TREATMENT (EBT)

What is EBT?

Scientists have discovered there are naturally occurring organisms present in the environment that can help to break down chlorinated solvents in groundwater, and turn them into safe, natural compounds. This process is known as bioremediation.

Enhanced bioremediation involves injecting natural nutrients into the groundwater as an additional food source for these tiny organisms. This speeds up the natural process by encouraging the growth and development of more organisms. EBT has been used successfully at hundreds of cleanup sites across the country.

How do you know it will work at the Depot?

EBT has been used effectively at sites around the world. During a year-long pilot study completed in 2003, the Depot's environmental team set up two test sites where organic nutrients were injected into the groundwater. Vegetable oil was used at one site and sodium lactate was used at the other, to compare the effectiveness of the substances. The results of the study showed that multiple injections of sodium lactate will be the most effective solution for treating solvents in the shallow aquifer beneath the Main Installation (MI).

Additional monitoring wells will also be installed to ensure the effectiveness of the treatment. USEPA and TDEC will review the effectiveness of the cleanup remedy at five-year intervals to ensure the site continues to be safe for community reuse.

Where will it be used at the Depot?

EBT was selected as the remedy for groundwater at the Main Installation. During the winter of 2005/06, EBT will be implemented in two areas of the MI where concentrations of solvents are the highest. In the southwest corner of the MI, 16 injection wells will be used to introduce sodium lactate into the groundwater. In the southeast corner, nine injection wells will be used. Injections will occur bi-weekly during the first year of treatment and then reduce to a monthly schedule until the cleanup goals are reached.

Additional monitoring wells will also be installed to ensure the effectiveness of the treatment. USEPA and TDEC will review the effectiveness of the cleanup remedy at five-year intervals to ensure the site continues to be safe for community reuse.

Is EBT safe?

Bioremediation is very safe because it relies on microbes that naturally occur in soil. These microbes are helpful and pose no threat to people at the site or in the community. The nutrient that will be added to make the microbes grow is a natural substance, sodium lactate.

Once cleanup targets have been met, the nutrients will no longer be added, and the condition of the microbes will return to its natural state.

The Record of Decision (ROD) for the Main Installation provides a complete analysis of the selected remedies. Each remedy and technology was thoroughly evaluated for safety and efficacy.

Will EBT affect the drinking water?

No. The affected groundwater is in the shallow aquifer known as the fluvial aquifer. This aquifer is about 90 feet below the ground surface. This water is not used for drinking water, so there is no exposure to the community. The city's drinking water is drawn from the Memphis Sand aquifer, located roughly 250 feet below the ground surface.

How can I find out more about EBT?

More information on EBT is also available on USEPA's website at <http://www.epa.gov/swertio1/download/citizens/bioremediation.pdf>.

MONITORED NATURAL ATTENUATION (MNA)**What is Monitored Natural Attenuation (MNA)?**

Natural attenuation relies on natural processes to clean up or *attenuate* pollution in soil and groundwater. Scientists monitor or test these conditions to make sure natural attenuation is effective at a particular site. This is called *monitored natural attenuation* or *MNA*.

MNA may reduce compounds in several ways: breaking them down into individual components through biodegradation; reducing their concentration through dilution, dispersion or evaporation; or binding them to soil through adsorption so that the compounds do not spread or migrate off site.

How is MNA being used at the Depot?

MNA is part of the approved remedy for groundwater at the Main Installation and will be used to treat groundwater containing low levels of solvents or volatile organic compounds (VOCs), in the shallow aquifer beneath the MI and for a limited area west of Dunn Field. MNA will complement the ZVI and Enhanced Bioremediation Treatment (EBT) that will be implemented in areas where the shallow aquifer has higher concentrations of VOCs.

The Depot will implement long-term groundwater monitoring to document changes in concentrations and to ensure compounds do not migrate off-site or into deeper aquifers.

How do you know it will work?

MNA has been used successfully at cleanup sites around the world and has been found to work just as well and almost as fast as other cleanup methods. It works best when the source of pollution has been removed or remediated using an active treatment.

The Record of Decision (ROD) for the Main Installation provides a complete analysis of Monitored Natural Attenuation as part of the selected remedy for groundwater. It was thoroughly evaluated for safety and efficacy.

USEPA, DLA, and TDEC will review the effectiveness of this remedy at five-year intervals to ensure the site continues to be safe for community reuse.

How can I find out more about MNA?

More information can be found in the USEPA's *A Citizen's Guide to Monitored Natural Attenuation*, located online at <http://www.clu-in.org/download/citizens/mna.pdf>.